Rec'd PCT/PTO 25 JUN 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Kurt FRANK

Based on PCT/DE 01/02234

For: RADIAL PISTON PUMP

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, Between the title and paragraph [0001] insert the following:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 U.S.C.371 application of PCT/DE 01/02234, filed on June 15, 2001.

[0000.6] BACKGROUND OF THE INVENTION

Replace paragraph [0001] with the following rewritten paragraph:

[0001] Field Of The Invention

Between paragraphs [0002] and [0003] insert the following:

[0002.5] Description Of The Prior Art

Replace paragraph [0003] with the following rewritten paragraph:

[0003] A radial piston pump of the generic type described above is known from German Patent Disclosure DE 198 47 044 A1. In the known radial piston pump, an annular groove which communicates with a plurality of axially disposed grooves or channels is made in the outer jacket face of the pistons in the circumferential direction. The macroscopic channels serve to orient the pistons "hydraulically", each in the associated element bore.

Page 2, Between paragraphs [0005] and [0006] insert the following:

[0005.5] SUMMARY OF THE INVENTION

Delete paragraph [0007]:

Replace paragraph [0008] with the following rewritten paragraph:

[0008] The running paths formed on the piston jacket face and in the element bore can, in the radial piston pump of the invention, be embodied very smoothly and accurately in terms of shape. As a result, very small plays are attainable, which especially at high pressures, because the gap losses are so slight, leads to good efficiency of the radial piston pump. The smooth surfaces would, however, hinder adequate lubrication in operation of the radial piston pump and would cause the pistons to seize. The targeted structuring of the surface of the pistons and/or of the element bores has the function of lubricant pockets and lubrication channels. The structuring can be made in a targeted way, for instance with the aid of a laser. Via the structure made in the surface, the lubricant medium is distributed during operation to the lubrication points to be supplied along the running paths. At the same time, the structuring acts as a reservoir for the lubricant medium.

Page 3, Replace paragraph [0010] with the following rewritten paragraph:

[0010] A further particular embodiment of the invention is characterized in that the structure is formed by lubrication channels, which extend substantially in the circumferential direction. By this means, it is attained in a simple way that there is no communication between the low-pressure region and the high-pressure region. The size of the storage reservoir for the lubricant medium can be defined by way of the number of lubrication channels.

Replace paragraph [0011] with the following rewritten paragraph:

[0011] Another particular embodiment of the invention is characterized in that the structure is formed by lubrication channels, disposed in pairs, each of a different length, which each have arms oriented perpendicular to one another, with one arm disposed in the axial direction and the other arm in the circumferential direction of the respective jacket face. As a result, especially good distribution of the lubricant over the surface to be lubricated is achieved.

Replace paragraph [0012] with the following rewritten paragraph:

[0012] Another particular embodiment of the invention is characterized in that the structure is formed by many axially extending channels, which are disposed in groups and which communicate with one another through channels extending circumferentially. In this type of in-line connection, the flow resistance in the axial direction can be varied by way of the number of channels extending axially. By means of additional connecting channels in the circumferential direction, the lubrication in certain regions can be improved in a targeted way. The flow resistance is furthermore dependent, among other factors, on the parameters of channel shape, channel cross section and channel length. By a suitable choice of these parameters, the supply of lubricant can be designed to suit what is needed.

Page 4, Replace paragraph [0013] with the following rewritten paragraph:

[0013] BRIEF DESCRIPTION OF THE DRAWINGS

Replace paragraph [0014] with the following rewritten paragraph:

[0014] The invention will be described in detail herein below, with reference to the drawings, in which:

Page 5, Replace paragraph [0019] with the following rewritten paragraph:

[0019] DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 6, Replace paragraph [0024] with the following rewritten paragraph:

[0024] In Fig. 1, a developed view is seen of the jacket face of a piston of a radial piston pump of the invention. Reference numeral 1 indicates the high-pressure region and reference numeral 2 the low-pressure region of the radial piston pump. The developed view of the piston jacket face is identified overall by reference numeral 3. In the piston jacket face, a plurality of lubrication channels 4, 5, 6, 7 and 8 extending in the circumferential direction are disposed parallel to one another. Toward the high-pressure region 1, the lubrication channels are spaced closer together than toward the low-pressure region 2. The individual lubrication channels do not communicate with one another and in practical terms are connected parallel.

Replace paragraph [0025] with the following rewritten paragraph:

[0025] Fig. 2 is a perspective view of an element bore 20 in section. On the inner circumferential face of the element bore 20, there are a plurality of lubrication channels 4, 5, 6, 7 and 8 extending in the circumferential direction.

Replace paragraph [0026] with the following rewritten paragraph:

[0026] In Fig. 3, a developed view of the jacket face of a piston in a further embodiment of the invention is shown. In the embodiment shown in Fig. 3, ten lubrication channels 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 each are combined into one group. The lubrication channels 9-18 are L-shaped. One leg of an L-shaped lubrication channel is disposed in the circumferential direction, while the other leg is disposed in the axial direction. Two lubrication channels at a time, with legs of equal length axially, are disposed in pairs with one another in such a way that the legs in the circumferential direction face toward one another.

Page 7, Replace paragraph [0027] with the following rewritten paragraph:

[0027] In the embodiment shown in Fig. 4, a T-shaped lubrication channel 24 is disposed in the vicinity of the high-pressure region 1. The center axis of the T-shaped lubrication channel is oriented toward the high-pressure region 1. The T-shaped lubrication channel 24 is surrounded by or bracketed two L-shaped lubrication channels 25 and 26. From the circumferentially disposed legs of the L-shaped lubrication channels 25 and 26, a plurality of lubrication channels 27 extend axially. The axially extending lubrication channels 27 are intersected by a plurality of lubrication channel extending circumferentially. In Fig. 4, one of these circumferentially extending

lubrication channels is marked as an example with reference numeral 28. From the lubrication channels extending circumferentially, in turn a plurality of axially extending lubrication channels originate, of which one is shown as an example at 29 in Fig. 4. Adjoining these axially extending lubrication channels in turn are circumferentially extending lubrication channels 30. These are followed by lubrication channels 31 oriented axially and lubrication channels 32 oriented circumferentially.

Replace paragraph [0028] with the following rewritten paragraph:

[0028] The lubrication channels made by means of lasers are not continuous in the axial direction. The lubrication channels are interrupted, in order to keep the gap losses and leakage flows as slight as possible. The lubrication channels can form regular patterns, as shown in Figs. 3 and 4, or can be disposed irregularly.

After paragraph [0028] insert the following new paragraph:

[0029] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Page 8, Line 1, delete "Claims" and insert --"I Claim"--.

IN THE CLAIMS

Please cancel claims 1-5 and add new claims 6-13.

6. A radial piston pump for generating high fuel pressure in fuel injection systems of internal combustion engines, in particular in a common rail injection system, having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate fuel and subject it to high pressure in a high-pressure region, wherein the outer jacket face (3) of the pistons and/or the inner jacket face (20) of the element bore having , a structure in the µm range formed therein.

7. The radial piston pump of claim 6 wherein the structure is embodied such that in operation there is no direct communication between the high-pressure region (1), defined by one face end of the respective piston, and a low-pressure region (2), defined by the other face end.

8. The radial piston pump of claim 6 wherein the structure is formed by lubrication channels (4-8), which extend substantially in the circumferential direction.

9. The radial piston pump of claim 7 wherein the structure is formed by lubrication channels (4-8), which extend substantially in the circumferential direction.

10. The radial piston pump of claim 6 wherein the structure is formed by lubrication channels (9-18), disposed in pairs, each of a different length, which each have arms oriented perpendicular to one another, with one arm disposed in the axial direction and the other arm in the circumferential direction of the respective jacket face.

11. The radial piston pump of claim 7 wherein the structure is formed by lubrication channels (9-18), disposed in pairs, each of a different length, which each have arms oriented perpendicular to one another, with one arm disposed in the axial direction and the other arm in the circumferential direction of the respective jacket face.

12. The radial piston pump of claim 6 wherein the structure is formed by many axially extending channels (27, 29, 31), which are disposed in groups and which communicate with one another through channels (28, 30, 32) extending in the circumferential direction.

13. The radial piston pump of claim 7 wherein the structure is formed by many axially extending channels (27, 29, 31), which are disposed in groups and which communicate with one another through channels (28, 30, 32) extending in the circumferential direction.

IN THE ABSTRACT

Please substitute the attached rewritten Abstract of the Disclosure for the abstract as originally filed.

REMARKS

The above amendments are being made to place the application in better condition for examination.

Entry of the amendment is respectfully solicited.

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

The invention relates to a radial piston pump for generating high fuel pressure in fuel injection systems of internal combustion engines, in particular in a common rail injection system, having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate fuel and subject it to high pressure in a high-pressure region. In order to increase the efficiency and lengthen the service life, in the outer jacket face of the pistons and/or the inner jacket face of the element bore, a structure in the µm range is formed.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, Between the title and paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

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[0000.6] BACKGROUND OF THE INVENTION

Paragraph [0001] has been amended as follows:

[0001] ~~Prior Art~~ Field Of The Invention

Between paragraphs [0002] and [0003]:

[0002.5] Description Of The Prior Art

Paragraph [0003] has been amended as follows:

[0003] A radial piston pump of ~~this~~ the generic type described above is known from German Patent Disclosure DE 198 47 044 A1. In the known radial piston pump, an annular groove which communicates with a plurality of axially disposed ~~conduits~~ grooves or channels is made in the outer jacket face of the pistons in the circumferential direction. The macroscopic ~~conduits~~ channels serve to orient the pistons "hydraulically", each in the associated element bore.

Page 2, Between paragraphs [0005] and [0006]:

[0005.5] SUMMARY OF THE INVENTION

Deleted paragraph [0007]:

[0007] ~~Advantages of the Invention~~

Paragraph [0008] has been amended as follows:

[0008] The running paths formed on the piston jacket face and in the element bore can, in the radial piston pump of the invention, be embodied very smoothly and accurately in terms of shape. As a result, very small plays are attainable, which especially at high pressures, because the gap losses are so slight, leads to good efficiency of the radial piston pump. The smooth surfaces would, however, hinder adequate lubrication in operation of the radial piston pump and would cause the pistons to seize. The targeted structuring of the surface of the pistons and/or of the element bores has the function of lubricant pockets and lubrication ~~conduits~~ channels. The structuring can be made in a targeted way, for instance with the aid of a laser. Via the structure made in the surface, the lubricant medium is distributed during operation to the lubrication points to be supplied along the running paths. At the same time, the structuring acts as a reservoir for the lubricant medium.

Page 3, Paragraph [0010] has been amended as follows:

[0010] A further particular embodiment of the invention is characterized in that the structure is formed by lubrication ~~conduits~~ channels, which extend substantially in the circumferential direction. By this means, it is attained in a simple way that there is no communication between the low-pressure region and the high-pressure region. The size of the storage reservoir for the lubricant medium can be defined by way of the number of lubrication ~~conduits~~ channels.

Paragraph [0011] has been amended as follows:

[0011] Another particular embodiment of the invention is characterized in that the structure is formed by lubrication ~~conduits~~ channels, disposed in pairs, each of a different length, which each have arms oriented perpendicular to one another, with one arm disposed in the axial direction and the other arm in the circumferential direction of the respective jacket face. As a result, especially good distribution of the lubricant over the surface to be lubricated is achieved.

Paragraph [0012] has been amended as follows:

[0012] Another particular embodiment of the invention is characterized in that the structure is formed by many axially extending ~~conduits~~ channels, which are disposed in groups and which communicate with one another through ~~conduits~~ channels extending circumferentially. In this type of in-line connection, the flow resistance in the axial direction can be varied by way of the number of ~~conduits~~ channels extending axially. By means of additional connecting ~~conduits~~ channels in the circumferential direction, the lubrication in certain regions can be improved in a targeted way. The flow resistance is furthermore dependent, among other factors, on the parameters of ~~conduit~~ channel shape, ~~conduit~~ channel cross section and ~~conduit~~ channel length. By a suitable choice of these parameters, the supply of lubricant can be designed to suit what is needed.

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[0013] ~~Drawing~~ BRIEF DESCRIPTION OF THE DRAWINGS

Paragraph [0014] has been amended as follows:

[0014] ~~Shown in the drawing are:~~ The invention will be described in detail herein below, with reference to the drawings, in which:

Page 5, Paragraph [0019] has been amended as follows:

[0019] ~~Description of the Exemplary Embodiments~~ DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 6, Paragraph [0024] has been amended as follows:

[0024] In Fig. 1, a developed view is seen of the jacket face of a piston of a radial piston pump of the invention. Reference numeral 1 indicates the high-pressure region and reference numeral 2 the low-pressure region of the radial piston pump. The developed view of the piston jacket face is identified overall by reference numeral 3. In the piston jacket face, a plurality of lubrication ~~conduits~~ channels 4, 5, 6, 7 and 8 extending in the circumferential direction are disposed parallel to one another. Toward the high-pressure region 1, the lubrication ~~conduits~~ channels are spaced closer together than toward the low-pressure region 2. The individual lubrication ~~conduits~~ channels do not communicate with one another and in practical terms are connected parallel.

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After paragraph [0028]:

[0029] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

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Page 9, Abstract

~~Abstract~~ **<u>ABSTRACT OF THE DISCLOSURE</u>**

The invention relates to a radial piston pump for generating high fuel pressure in fuel injection systems of internal combustion engines, in particular in a common rail injection system, having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate fuel and subject it to high pressure in a high-pressure region. In order to increase the efficiency and lengthen the service life, in the outer jacket face ~~(3)~~ of the pistons and/or the inner jacket face of the element bore, a structure in the μm range is formed.

~~(Fig. 1)~~